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Femoral Bone Mineral Content and Cortical Thickness in Aleut and Eskimo Adults

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The use of ^{125}I photon absorptiometry has been very productive in the acquisition of skeletal information, including age-related changes in skeletons of living and deceased subjects. The technique, developed by Cameron and Sorenson in 1963, has been applied to sev-everal living populations, both normal and clinical. Although most normative data on living subjects have been derived from the fore-arm site, in many skeletal collections, radii and ulnae are frag-mented or missing, whereas femora are available for a greater number of individuals.

Bone mineral data were available from living Eskimo groups in Alaska and Canada (Mazess and Jones, 1972; Mazess and Mather, 1975) and were used as a comparison group to the Upernavik Eskimo skeletal collection. Investigations in living Eskimos demonstrated that the Eskimos have lower bone mineral content than U.S. White or Black groups above 40 years of age. It was also noted (Gunness-Hey, 1977; Merbs, 1963; Stewart, 1931) that both pre-contact and later Eskimos examined had a very high incidence of osteological (primar-ily vertebral) pathologies and anomalies, including vertebral col-lapse. Life expectancy studies on Aleut and Eskimo groups (Harper, 1975) show a major dichotomy in length of life between these two groups. For example, Aleut males of age 10 - 19 could expect to live another 41.44 years. Eskimo males in the Wainwright region, of the same age, had a life expectancy of only 28.65 years. These patterns are consistent throughout the Arctic. The combination of short length of life, increased bone pathologies and generally low bone mineral content in all Eskimo groups studied, suggests a tangible relationship between these variables in the Eskimo. On the basis of life expectancy data, Laughlin and Harper (1976) hypothesized that Aleuts should have a higher bone mineral content than comparable Eskimos.

The sample used in this study consisted of two northern populations: 1) Aleuts of the Aleutian Islands; and 2) Eskimos of the Upernavik region of Greenland, which share a common ancestry. The current invesitgation was designed to test the hypothesis that differences exist in bone mineral content and cortical thickness between the skeletons of the Aleut and Eskimo groups. Femora were used throughout.

Measurement of bone mineral content (BMC) was made across the midshaft of the femur using a Norland-Cameron Bone Mineral Analyzer. This device uses a photon emitting source (^{125}I) and a sodium iodide scintillation counter mounted on a moving arm, to scan across the bone. The number of photons passing through the bone is inversely proportional to its mineral content. Absorptiometrically derived bone mineral content has been shown to be highly correlated (r .94) to the total body calcium and other mineral measurements (Chestnut et al., 1973). The scanner gives a digital readout of BMC in g/cm and bone width in cm. The BMC measurement is an absolute amount of mineral across the scan path (along the length of the bone) which is 3 mm wide (Figure 1). The simultaneous measurement of bone width across the width of the bone is also given, in cm. The ratio of these two values provides us with a bone mineral index, i.e., with relative information which relates the absolute mineral content to the size of the bone being measured.

Cortical thickness is measured directly from a core taken at the femoral midshaft using dental calipers. A core of bone .4 cm in diameter is removed with a specially constructed drill bit mounted in a high speed Dremel drill. This technique minimizes the cosmetic damage to a bone, unlike other methods which require the removal of a complete cross-section of bone for histological analysis.

The skeletal sample used in this study is part of the collection of the Laboratory of Biological Anthropology at the University of Connecticut. This investigation included a group of 114 adult individuals; 34 Aleut males, 17 Aleut females, 32 Eskimo males and 31 Eskimo females. The age composition of the sample is assumed to be representative due to the random collection procedure.

The Aleut skeletons were collected in the Aleutian Islands by Dr. W.S. Laughlin. The excavation sites included Kagamil (cave burials), Umnak (below ground burials), Atka and the Rat Islands. In a brief pilot study on the effects of various types of interment, no significant differences were found between the different types of burials with respect to bone mineral content (Frank, 1979). The Eskimo skeletons constitute the last heathen series from Upernavik, Greenland.

TABLE 1

Bone Mineral Content (g/cm)

	n	$\bar{x}$	s.d.	t	
Aleut Male Femora	34	4.11	.48	5.25	($p < .001$)
Eskimo Male Femora	32	3.47	.51		
Aleut Female Femora	17	3.26	.47	2.88	($p < .01$)
Eskimo Female Femora	31	2.80	.54		

Bone mineral content values in g/cm for the 114 specimens are shown in Table 1. Bone mineral content in g/cm is an absolute value of the amount of mineral in the bone cross-section. These data show Aleuts to have a greater absolute amount of mineral in the femur than the Eskimos in both male and female subsets. The difference between the Aleut male mean (4.11) and the Eskimo male mean (3.47) had a t-value of 5.25, and was significant at the level of p .001. The Aleut female mean (3.26) differed from the Eskimo female mean (2.80) with a t-value of 2.08, which was significant at the level p .01. Sexual dimorphism is also obviously apparent within each population.

TABLE 2

Bone Mineral Content (g/cm^2)

	n	$\bar{x}$	s.d.	t	
Aleut Male Femora	34	1.52	.17	4.41	($p < .001$)
Eskimo Male Femora	32	1.33	.17		
Aleut Female Femora	17	1.31	.20	2.11	($p < .05$)
Eskimo Female Femora	31	1.17	.21		

Bone mineral content in g/cm^2 is termed the bone mineral index, a value of the relative mineral content with respect to the size of the bone. These values are presented in Table 2. The Aleuts of both the male and female groups demonstrated higher levels of bone mineral than their Eskimo counterparts. The t-value for the Aleut male mean (1.52) and the Eskimo male mean (1.33) was 4.41, significant at the level $p < .001$. The Aleut female mean (1.31) was different from the Eskimo female mean (1.17) with a t-value of 2.11 at a significance level of $p < .05$.

TABLE 3

Cortical Thickness (mm)

	n	$\bar{x}$	s.d.	t	
Aleut Male Femora	34	4.68	.98	5.09	($p < .001$)
Eskimo Male Femora	32	3.47	.91		
Aleut Female Femora	17	4.08	.82	2.18	($p < .05$)
Eskimo Female Femora	31	3.55	.78		

The values for cortical thickness in mm are presented in Table 3. These values are in general agreement with the values obtained for bone mineral content and bone mineral index, with respect to the population differences between Aleuts and Eskimos. The correlation between cortical thickness and bone mineral content was expected to be in the range 0.69 to 0.83 as reported by Mazess et al. (1968). In this study the correlation was between 0.49 and 0.73 for the four subsets. The Aleut male mean (4.68) for cortical thickness was significantly different ($t=5.09$) at $p < .001$, from the Eskimo male mean (3.47). The same pattern was seen in the female group. The Aleut female mean (4.08) differs from the Eskimo female mean (3.55) with a t-value of 2.18, demonstrating significance at the level $p < .05$.

These results indicate that true population differences exist between Aleut and Eskimo groups with respect to three bone mineralization measurements. Research is in progress examining the reasons for these differences. Possibilities which have been reported include: 1) variation in nutritional status, and 2) variation in the rate of bone turnover as well as a correlation with (not a causal relationship) that has been noted with variation in length of life.

REFERENCES CITED

Cameron, J.R. and J.A. Sorenson 1963 Measurement of bone mineral in vivo: an improved method. Science 143:230.

Chestnut, C.B., E. Manske, D. Baylink and W.P. Nelp 1973 Correlation of total body calcium (bone mass) and regional bone mass. Clin. Res. 21:200.

Frank, E.E. 1979 Bone Mineralization and Age at Death in Aleut and Eskimo Skeletons. M.S. Thesis, in preparation, University of Connecticut.

Gunness-Hey, M. 1977 The Vertebral Column of the Koniag Eskimo, Kodiak Island, Alaska. M.S. Thesis, University of Connecticut.

Harper, A.B. 1975 Secular Change and Isolate Divergence in the Aleutian Population System. Ph.D. Thesis, University of Connecticut.

Laughlin, W.S. and A.B. Harper 1976 Nutrition, evolution and adaptation. Presented at the Symposium Anthropological Aspects of Human Nutrition, School of American Research, Santa Fe, NM, Oct. 11-15, 1976.

Mazess, R.B., J.R. Cameron and J.A. Sorenson 1968 A comparison of radiological methods for determining bone mineral content. In: Progress in Methods of Bone Mineral Measurement. U.S. Government Printing Office, Washington, D.C. pp. 455-482.

Mazess, R.B. and R. Jones 1972 Weight and density of Sadlermiut Eskimo long bones. Hum. Biol. 44:537-548.

Merbs, C.F. 1963 The Sadlermiut Eskimo Vertebral Column. M.A. Thesis, Department of Anthropology, University of Wisconsin.

Stewart, T.D. 1931 Incidence of separate neural arch in the lumbar vertibrae of Eskimos. Am. J. Phys. Anth. 16:51-62.

Figure 1

BONE PARAMETERS MEASURED BY PHOTON ABSORPTIOMETRY